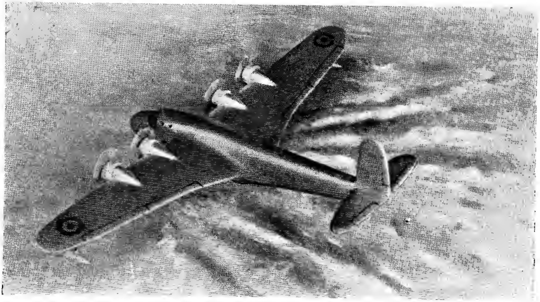
The "Bat," A Gauge "O" "Live Steamer"

THE MODEL ENGINEER

Vol. 82 No. 2035 • THURS., MAY 9, 1940 • SIXPENCE

In this issue

Not what it seems to be! It is really a clever example of "table-top" photography by Mr. L. H. Sparey. The aeroplane is a solid, scale reproduction of a modern flying boat; it has a wing-span of 8 in. It is alighting on "water" that is simply a piece of painted cardboard; the foam is shaving-soap suds applied to the surface by means of a brush. "Table-top" photography has received a great deal of attention in the popular press, lately, and Mr. Sparey's example is one of the most convincing we have yet seen, other than professional efforts.



THE MODEL ENGINEER

Vol. 82 No. 2035

60 Kingsway, London, W.C.2

May 9th, 1940

Smoke Rings

A Call for Volunteers

THE Defence Services are in urgent need of men to maintain and repair various kinds of scientific instruments used in the field. A number of experienced instrument mechanics of good general and technical education, capable of carrying out first-class work without supervision, is required, and a further number of slightly less experienced mechanics are also needed to carry out the maintenance and repair of these instruments. THE MODEL ENGINEER has been requested to assist in bringing this information to the notice of men with suitable experience, particularly men who are interested in model making, or similar work, as a hobby, and who are not following vital reserved occupations, and to men who would be suitable for training. Such men are invited to offer their services for enlistment in the Corps which has been created to deal with the work specified. The work is being handled by the Royal Army Ordnance Corps, and enlistment is offered in the following grades : (1) Armament artificer (instruments), comprising fully trained and experienced instrument mechanics who are given the rank and pay of Staff Sergeant ; (2) Instrument mechanics who are slightly less experienced, and come in a lower grade. Men of all ages are required, and in both grades there are good prospects of promotion for men of proved ability. We are sure there must be many readers and their friends who will welcome this chance of offering their services to the nation. Those who are willing to volunteer, or wish to obtain further information of conditions of service, should apply by letter to the Inspector of Army Ordnance Workshop Services, Caxton House West, Tothill Street, S.W.1. Letters should state that the application is made in response to the appeal in THE MODEL ENGINEER for instrument mechanics.

* * *

A National Service Opening for Model Engineers

I HAVE received a letter from an important electrical manufacturing firm in the South Lancashire area who have vacancies for a number of model engineers in their instrument making department. They are prepared to give training in the class of work required, and there is no age limit, provided applicants are reasonably physically fit. The firm writes :—" The type of mechanic we are needing and for which readers of THE MODEL ENGINEER might be suitable are men who in industry are known as instrument makers. This work is primarily of the hand craftsmen class (a class now not so numerous as formerly) making precision instruments and components to fine limits from proper manufacturing drawings, and, as such the accurate work done by model makers is very much akin to it. The tools used are mainly hand tools, drilling machines and lathes, particularly lathes of the South Bend type. These are just the tools which model makers are accustomed to using and although their equipment may not always be so lavish as in a modern industrial instrument shop, the excellence of the models turned out by many men in pursuit of their hobby testifies to the skill with which they can use them. Many men not directly in engineering, armament or supply trades are anxious to do something for the National interest, and in view of the shortage of skilled craftsmen, men whose hobby is model making may not have realised that the skill acquired through this hobby would be turned to good account, particularly amongst companies where training facilities have been developed. Such training in the case of an accomplished model maker would be primarily concerned with the ready use of hand tools, files, measuring instruments, bench lathes, and drilling machines, etc. This possibility of helping National interest may be particularly applicable to men who have retired from active business, or whose normal business may have suffered as a result of the war." I should be pleased to forward any letters to the firm in question if they are addressed to me and marked " Instrument Making " on the envelope.

* * *

Model Supply Troubles

THERE has been an increase in the number of complaints, lately, from readers who have sent orders to certain of our advertisers with very unsatisfactory results. The great majority of cases are typical of the following : A reader sends a definite order, with cash, to an advertiser ; then ensues a long wait during which there is no acknowledgement of the order, and no amount of subsequent enquiry on the part of the customer is replied to. This kind of thing does irreparable harm to the trade generally, especially in those cases where, eventually, the goods ordered are not delivered, even in part, after many months. While we have every sympathy with the trade, whose difficulties are no less than our own in these disturbed times, there is absolutely no excuse whatever for a flagrant lack of common courtesy ; nor have we any feeling but disgust for such advertisers as are obviously endeavouring to take advantage of the prevailing conditions as an easy means for justifying extreme laxity in business methods. We do not presume to teach the trade its business ; but, in view of the fact that there are certain firms against whom complaints are rapidly growing, we shall be compelled to take drastic steps, in fairness to our readers, in the endeavour to remedy a very undesirable state of affairs.

Percival Marshall

*Model Aeronautics

Instructions are here given for making and fitting the tail plane and fin for "Elf," the low-wing cabin monoplane

By Lawrence H. Sparey

It will be remembered that the tail portion of the fuselage was cut off from the main body between formers Nos. 14 and 15. To this detached portion the tail planes and rudder fin are fixed. Not only does this system supply a readily detachable tail fixing, but it enables the fuselage to be considerably shortened for transport purposes. In fact, "Elf" may be packed into a 36 in. suitcase, with plenty of room to spare; a boon to those who may have to travel any distance to a suitable flying ground. Model aeroplanes, being of a somewhat fragile nature, often present problems in safe transit.

I always think that the best method of describing any component is to present first a picture of the finished job. The builder is thus able to obtain some idea of what he is aiming at, and many intermediate steps become clearer. Fig. 150 shows the finished tail unit framework, wherein it will be noted, the rudder plane and underslung fin are cemented rigidly to the tail portion of the fuselage. The tail is made in halves, with short dowels affixed to the main spars, and plugging into sockets of celluloid tubing. In the picture, the tail socket may be seen as the second, small, dark circle from the front end. The nearer tail plane is shown detached.

A start should be made on the tail fin. Measure the diameter of the extreme end of your fuselage (marked [B] in Fig. 151) and also the diameter at (C). Set these measurements out on a sheet of paper, and continue the diverging lines to the point (A). This will form the basis for the drawing of the rudder and fin. Fig. 151 is exactly half scale, so that we may, from this, set out a full sized plan. The best method is to obtain a sheet of tracing paper large enough to cover Fig. 151, and, with a pencil, to draw a mesh of ¼ in. squares over the whole paper. This squared paper is now pinned down upon a board over Fig. 151. Next, take a sheet of drawing paper, and cover this in light pencil lines with a ½ in. mesh. In this way the irregular outline of the fin and rudder at any point may be ascertained by noting the square, or portion of a square, at which the point lies, when it may be transferred to the equivalent ½ in. square on the drawing paper. The scale will, of course, be automatically doubled in the process, and a fairly accurate outline of the full-sized fin obtained.

The outline being completed, the positions of the bracing struts and other components may be scaled off, and marked in. We should now have a drawing something like Fig. 151, but twice the size. I have roughly indicated the tail portion of the fuselage in this illustration, but you, of course, need not do this.

The framework of the rudder and fin is of 1/16 in. square birch. This may be easily bent to shape in the steam from a kettle, after which the framework should be pinned down over the drawing in the manner indicated in Fig. 152. This picture shows the rudder in course of construction, and, in conjunction with Fig. 151, should render the building quite simple. Cut all the bracing struts accurately to size from the job, and pin them in place, flat to the board, while the cement is setting.

It will be seen that a small trimming fin is let into the rear of the rudder. Beyond cementing in the trimmer framework, do not worry about this at the moment. Build the rudder edge from one continuous length of birch; this may be cut through later to free the trimmer. Fig. 152 gives an exact idea of the work at this stage.

When the cement is set, the trimmer may be freed by cutting small portions out of the framework with a safety razor blade, at the points shown, and by sliding the blade between any parts which may have become stuck to the main framework. The whole may now be removed from the board. It will be found that it has become stuck, at some points, to the paper, and it may be freed by sliding the razor blade under the framework. Use care here, as the framework is unsupported, and easily warped.

At this stage the framework may be cemented to the tail portion of the fuselage. To do this it is necessary to fill in, with small pieces of

* *Continued from page 392, "M.E.," April 18, 1940.*

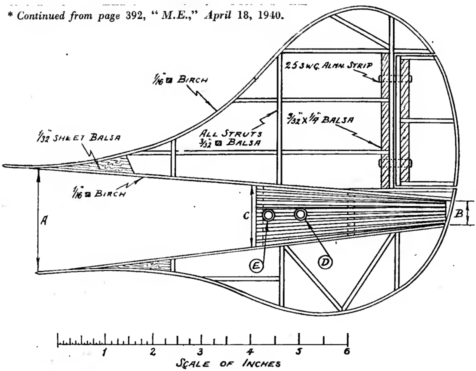


Fig. 151.

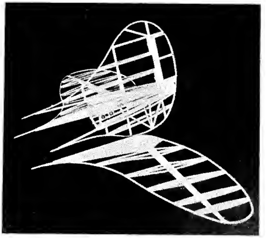


Fig. 150. The finished tail-unit framework.

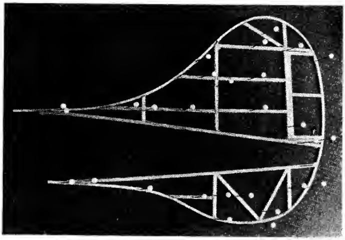


Fig. 152. First stage of rudder construction.

1/16 in. balsa, the spaces on the tail portion between stringers Nos. 1 and 16 on the top, and 8 and 9 on the bottom. This will provide platforms upon which the rudder frame may be cemented. Accuracy is required to ensure that the fin and rudder are affixed centrally between the specified stringers, and that the rudder is truly upright.

The rudder may now be finished. I feel that the drawing in Fig. 153 will explain the process better than many words. This illustration is an isometric drawing of the finished rudder frame, and I have omitted the stringers of the fuselage for the sake of clearness. As may be seen, the two uprights are supported on either side by small buttresses of balsa (A); while the underslung portion is strengthened by the addition of two small lengths of 3/32 in. × 1/16 in. balsa, which are cemented from stringers Nos. 6 and 11 down to the lower framework, in the form of a "V" (B). A symmetrical section is given to the rudder by the addition of strips of 1/32 in. balsa (C) cemented on as shown.

As the trimmer hinges on two small pieces of aluminium strip, it will be necessary to embed and cement these into the uprights of both rudder and trimmer (Fig. 151). The uprights should be carefully pierced with a broken safety razor blade before inserting the aluminium strips.

The diagram in Fig. 151 indicates the materials from which the rudder is made. Should the birch strip not be procurable, a similar section of bamboo split should be substituted. In this case, the framework will have to be bent under the action of dry heat, as steaming is ineffectual in bending bamboo. The split should be heated over the low flame of a gas ring, and be kept continually in movement to prevent charring. Between heatings it should be manipulated to shape with the fingers, and, when finished, plunged into cold water. This will held to retain the shape.

Before putting aside, as finished, the tail end of the fuselage, the sockets for the tail dowels should be fitted. The sockets consist of one piece of ⅛ in. bore celluloid tubing which is cemented across the fuselage between stringers Nos. 4 and 5 on one side, and 12 and 13 on the other. The position of this tube is indicated at (D) in Fig. 151. The other tube shown in this drawing (marked [E]) does not pass right through the fuselage from one side to the other. It is really the end of a small piece of celluloid tube, about 3/16 in. long, which is cemented hard against the first former of the tail portion. On the other side of the fuselage there is a similar piece of tubing, and their purpose is to locate a bamboo peg which serves as an anchorage for the rear end of the rubber motor skein. Should celluloid tubing not be procurable, the tubes may be rolled from several wraps of gummed paper parcel tape, wrapped around a piece of ⅛ in. dowel, which is immediately withdrawn before the gum is set.

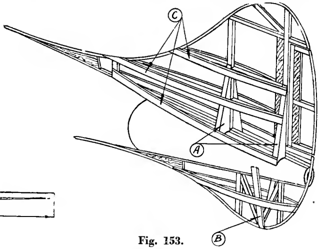


Fig. 153.

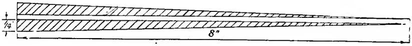


Fig. 155.

Construction of the tail planes follows, generally, that used for the rudder. Fig. 154 is a half scale drawing of the right-hand plane. It will be remembered, of course, that planes are right and left handed; therefore, in preparing the drawings, one will be reversed. The outline will again be obtained by means of the squared paper system, and the positions of the struts marked out. As an aid to conformity in steaming the birch tail edging, it is advisable to bind, with cotton, two birch strips together, and to steam them to shape in one operation. This ensures

that each tail plane is identical in shape with the other. The drawing of the tail plane in Fig. 154 shows the primary steps in construction, and when the job has progressed to this point it is in an equivalent stage of manufacture to the rudder shown in Fig. 152. When removed from the building board several additions must be made.

In the first place, the main spar must be built up into a tapering section. This is done in the manner indicated in Fig. 155 ; that is, by cementing long, wedge-shaped pieces of 3/32 in. balsa (shown shaded) to the top and bottom of the existing spar. Next, the tail section must be formed by cementing strips of 1/32 in. balsa, 1/8 in. wide, across the tail above each cross strut. These strips are cemented to the leading edge, over the built-up main spar, to the trailing edge. This will produce a cambered surface over which the covering tissue may later be stretched. The camber is equal on both top and bottom surfaces of the tail planes. I trust that the drawing in Fig. 156 will make these processes clear. The portion marked (B) represents a shaped piece of 1/32 in. balsa sheet, which is cut to fit between the strips (A) (A). It may be easier to cement first this strip to the main structure, and then apply the covering strips (A) (A). These strips should be 1/8 in. wide, and should overlap the end of the main spar by about 1/4 in., as may be seen at the point marked (C) in the illustration.

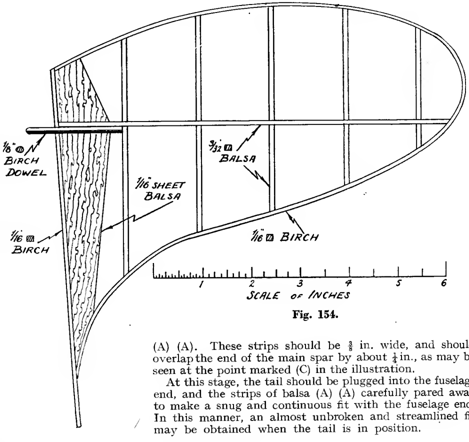


Fig. 154.

At this stage, the tail should be plugged into the fuselage end, and the strips of balsa (A) (A) carefully pared away to make a snug and continuous fit with the fuselage end. In this manner, an almost unbroken and streamlined fit may be obtained when the tail is in position.

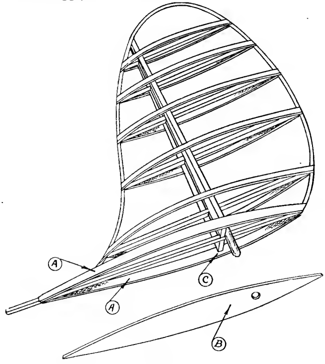


Fig. 156.

Cast Iron Pistons

It appears that my remarks about testing small I.C. engines, and particularly the reference to cast-iron pistons for the real miniatures, have struck some chords in the hearts of other model engineers who have suffered from the vagaries of these little mechanisms, and I continue to receive letters from interested readers.

One letter from Mr. B. C. J. Poole, of Hawkhurst, Kent, endorses my opinion that cast iron pistons are more suitable than the alloy ones for engines under 5/8 in. bore, and adds that he has cured the starting troubles of several engines which have been brought to him, by this simple expedient. Furthermore, I am able to endorse some remarks of his about the bad wearing qualities of some phosphor-bronze bearings in these small sizes. After quite a short while the wear is so great that serious loss of crankcase compression is apparent. In practice, Mr. Poole has found that the remedy is to fit cast iron main bearings, which, he says, are almost everlasting if they are a good fit on the shaft in the first place. They should be carefully lapped in. This is a good tip, and worth handing on to others.

Another piece of information, particularly useful at this time, is in the matter of obtaining suitable cast-iron in round rods. Mr. Poole assures me that a visit to any local builder's yard will procure some of the old fashioned cast-iron weights such as were used on the old-time sash window lines. The iron, he says, is usually close grained and free from blow holes. Readers will be well advised to follow this hint before most of this old scrap is collected.

Other interesting letters will be dealt with as space permits.

(To be continued)

"The Bat"

By "L.B.S.C."

Water-tubes and Bushes

FOLLOWERS of these notes who are building the "Bat" and have not yet arrived at the air test stage, will be exceedingly glad to learn that reports have already come in from those who have; and the general verdict is, that not only is the power there, but it is amazing the number of revolutions that the wheels will turn on one solitary stroke of an ordinary cycle pump. This is a good indication that the steam consumption will be low, something which your humble servant always aims at, so that the boiler will be what the enginemen call "boss of the job." Neglect of this point in the days of not-so-long-ago, was the cause of the outsize and freak boilers of even date, when the idea of a tiny inner barrel only $1\frac{1}{4}$ in. diameter and 6 in. long, fired by a spirit burner, maintaining steam for a pair of cylinders $\frac{3}{8}$ in. by $\frac{5}{8}$ in., would have been laughed to scorn. But we live and learn!

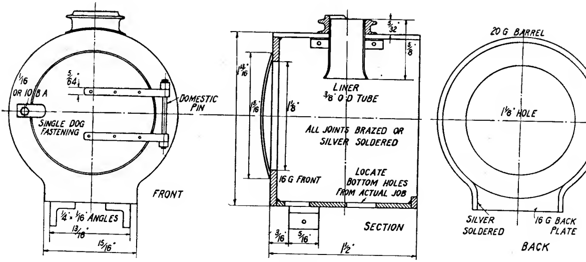
Turning attention to that same little barrel, the next job is to put the water tubes in it. There are three of these, 5/32 in. in diameter, and 24 gauge. The easiest way to get the short bends on the back end, without wasting metal, is as follows. A length of tube, say $13\frac{1}{2}$ in., is first annealed and cleaned up; make it red-hot, drop in the pickle bath, wash off, and rub with a bit of fine emery-cloth or steel wool. Put your thumb about $3\frac{1}{2}$ in. from one end, and bend the tube over the top of it. This is the best anti-kink method I have ever used! Cut the bend off short; then bend the remaining piece of tube to the shape of a hairpin (if you recollect what that was like—it is a long time since I saw one) by the same means, and cut through the centre of the bend; there are your tubes. Clean off the burrs; drill the holes in underside of boiler barrel, and fit the tubes on the late Mr. Averill's system. For new readers' benefit, this consists of distorting the holes in the forward part of the boiler barrel, so that the tubes enter straight; and if a piece of 5/32 in. steel rod is pushed into each hole, and forced down toward the back of the boiler until it reaches the position the tube will occupy, the holes will assume the requisite shape and angle for the tubes to be fitted.

The bushes can be made and fitted. These consist of three $\frac{1}{4}$ in. by 40 bushes turned from bronze or copper rod $\frac{3}{8}$ in. diameter, two for safety valves and one for regulator; also a 3/16 in. by 40 bush, turned from 5/16 in. rod, can be fitted anywhere on the backhead for the feed water clack. No water-gauge is necessary, as the boiler can come to no harm if it runs dry, whilst the available space is too small to accommodate a gauge that would give a correct reading. The stem of the tee forming the turret or fountain, is screwed through the backhead flange, on top of the barrel; and the blower pipe will pass to the side of barrel, not through it.

Use silver-solder to fix tubes and bushes; either "Easy-flo" plus "Tenacity No. 3," or No. 1 grade silver-solder plus Boron compo or jeweller's borax. The whole lot can be done at one heat; do not let the tube get hotter than a dull red, because burnt tubes have a nasty knack of going off pop under high pressure. I have had experience of that, when repairing commercial engines. The assembly of inner barrel, tubes and backhead, is attached to the wrapper, after insertion, by a few 9-BA screws run through the edge of wrapper, into tapped holes in the backhead flange. No front-end support is needed.

Smokebox for Loco-type Boiler

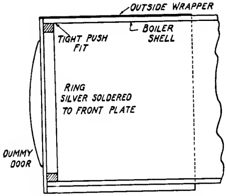
This may be either a single flat-bottomed box, or a double one having a circular body, same size as boiler barrel, enclosed in a wrapper like the water-tube edition described below. The easiest way to make the first-mentioned, is to get a piece of $1\frac{3}{4}$ in. diameter by 20 gauge brass tube, and turn it to a dead length of $1\frac{1}{2}$ in. It is then sawn longitudinally, the sawn ends softened, and opened out to form the bottom edges of the smokebox, which rest on the frame. The shell can also be bent up from a $1\frac{1}{2}$ in. strip of 20 gauge brass or steel sheet. Steel is good for smokeboxes, inasmuch as it does not get so



Loco-type smokebox for the "Bat."

hot as brass ; but wet ashes, etc., corrode thin ferrous metal, so that brass is really preferable. One great advantage of steel, from a novice's point of view, is that he can braze it up with a blowlamp, using ordinary brass wire instead of silver-solder, without the least risk of the whole outfit " fading away like a beautiful dream."

A front platc is cut from 16 gauge metal, and fitted to the shaped barrel ; this has a 1⅛ in. hole cut in it. Care should be taken to get the correct width at bottom, so that the smokebox will line up nicely with the frames. Tie a fcw strands of iron binding wire around the smokebox, and silver-solder or braze the front in, according to whether it is brass or steel. Now cut another piece of 16 gauge metal, like an abbreviated throatplate, and fit it to the bottom, at the back of the shell, so as to leave a circular hole matching the end of the boiler barrel. This also is brazed or silver-soldered in. Finally, cut a piece of metal, anything between 16 and 20 gauge, and fit it inside, flush with the rectangular bottom, brazing or silver-soldering that also ; and there is your smokebox, all ready for trimming up. Its personal appearance at this stage is



Smokebox for the water-tube boiler.

very similar to that of the one-piece cast smokeboxes sold by the long-since-departed (and very much lamented) firm of James Carson and Co. Ltd.

Smokebox Fitments

The chimney liner is a ⅝ in. length of ⅜ in. brass or copper tube—an odd end of 2½ in. gauge boiler tube will do fine for this—squared off at both ends and belled out a little at the bottom. Drill a ⅜ in. hole in a piece of brass or copper sheet about ¾ in. square ; anneal, and bend to the curve of the inside of the smokebox. Poke the end of the liner through the hole from the concave side, so that about 3/16 in. projects ; then silver-solder it, using the weeniest amount of silver-solder possible for a sound joint. Drill a ⅜ in. hole in the top of the smokebox ; see, too, that it *is* the top, for there will be no turning the smokebox around a bit, to correct a lopsided hole, as a good many novices do with a circular smokebox ! Push the liner through the hole from the inside of the smokebox, putting a smear of plumbers' jointing around the tube, and bed the square flange nicely against the inside of the smokebox, securing it with four 1/16 in. or 10 BA screws and nuts.

The Outer Chimney

The outer chimney can be turned from a bit of ⅝ in. brass rod ; or if you want to save work, one of Bond's die-castings can be used, their Southern standard chimney for " O " gauge being the identical gadget for the job. The chimney is not fixed, merely a push fit on the liner. If the ready-made chimney is purchased, get one of the same people's dome covers to match, which will save more work later on. I believe Bond's also supply a smokebox front, complete with door and hinges, which could be pressed into service ; but it would need to be in brass or bronze, as the ordinary whitemetal die-castings usually supplied for clockwork and electric outfits will not stand the racket of real steam locomotive work.

Smokebox Door

However, a smokebox door can be made very easily from sheet brass. If a disc of ⅛ in. thickness is used, the door can be turned out of it without any need for dishing. Solder the disc on to the end of a piece of rod, say about ½ in. diameter, and chuck in three-jaw ; the door can then be turned to shape and correct diameter, and the inside faced for about ¼ in. depth (use a left-hand knife tool for this) at the one chucking. Regarding shape, please yourself about that ! The " V " class on the Southern have doors like an exceedingly flat cone in section, and this is quite easy to turn up ; but some folk prefer the usual door with a regular curve. Incidentally, may I once more proclaim to all and sundry that the " Bat " is *not* supposed to be a Southern Railway " V " class engine, but merely a gauge " O " " live steamer " based on that type ? This may answer once and for all the good folk who keep on writing and telling me that the big sisters have Walschaerts valve gear, different guide bars and crossheads, and goodness knows what else. If anybody wants to turn the " Bat " into a genuine 100 per cent. " Schools " engine, they are perfectly welcome ; but a gauge " O " Walschaerts gear, for example, is not *quite* as robust as the arrangement I have given, nor can it be made so quickly. My honest advice is to " follow the words and music," and build the little engine as I describe her.

A Finicky Job

Fixing the strap hinges is going to be a finicky job, if they are to look anything at all like proportionate. They should be about 5/64 in. wide, and about 1/32 in. in thickness. For rivets, use dolls' pins (lill pins is the drapery trade term for them). A million of them would not make much of an addition to Uncle Adolf's birthday present, although their presence would immediately be apparent if he sat on them ! The lugs on the smokebox front can be turned up from a bit of 3/32 in. square brass ; the stems are screwed 1/16 in. or 10 BA, and the projecting part rounded off to match the end of the hinge straps. An ordinary domestic pin can be used for the hinge pin, holes being drilled according to size of pin. Those we have here at present need a No. 60 drill.

No dart nor crossbar is needed, the door being kept tightly closed by a single dog opposite the hinges. This is filed up to wedge shape from a piece of 3/32 in. square stuff, and attached to the smokebox front by a single 1/16 in. or 10 BA screw, hexagon-headed for preference. The thin end of the wedge holds the edge of the door, and the butt supports the outer end and prevents the screw bending or breaking off. A quarter turn of the screw allows the dog to be turned around clear of the door. The absence of a crossbar is a desirable feature on such a little engine.

Attachment to Boiler and Frames

When the small back section has been made and fitted, there will be a circular opening in the back of the smokebox, the same diameter as the inside of the boiler barrel. A ring of the same tube as used for boiler barrel, about ½ in.

(*Continued on page* 463)

Railway Practice

By Chas. S. Lake, M.I.Mech.E., M.I.Loco.E.

The "Immingham" Class Engines of the L.N.E.R.

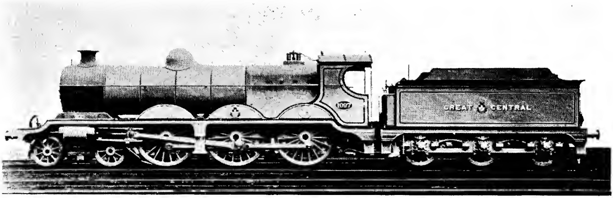
IN or about the year 1907 Mr. J. G. Robinson, then Chief Mechanical Engineer of the Great Central Railway designed a 4-6-0 type passenger locomotive for handling the heavier trains running between Manchester (Central) and London (Marylebone). The engines were known as the "Immingham" class, and the writer, who was proud to number Mr. Robinson among his best railway friends, made numerous footplate trips on the engines, recording some very excellent performances in both the "up" and "down" directions. The loads often consisted of 14 to 16 heavy bogie coaches and the schedule timings on certain sections was over 60 m.p.h.

The design may be classed as a good straightforward one well up to and, indeed, in many respects ahead of its time. There are two outside cylinders 19½ in. diameter by 26 in. stroke driving the middle pair of 6 ft. 6 in. coupled wheels. As designed the steam distribution valves were of the "D" or flat type actuated by Stephenson link motion with eccentrics mounted on the driving axle in the usual manner. The connecting-rods measured 11 ft. 3 in. between centres, and the coupling-rods 7 ft. 3 in. for both sections similarly computed. The coupled wheelbase is 14 ft. 6 in., and total engine wheelbase 26 ft. 9½ in.

The boiler barrel is placed with its centre 8 ft. 6 in. above rail level; it has a diameter of 4 ft. 9½ in. outside at the smokebox, and 5 ft. 0 in. at the firebox end. The distance between tube plates is 15 ft. 4⅜ in., and there are 221 steel tubes 2 in. outside diameter. No superheating apparatus was fitted when the engines were built, and the heating surfaces were, tubes 1,777.9 sq. ft., firebox 133.1 sq. ft., a total of 1,991 sq. ft., a very respectable total for an engine 33 years back. The grate area is 26 sq. ft., and boiler pressure 200 lb. per sq. in. In working order the engine weighs 70 tons 10 cwt., and the tender (4,000 gallons water and 5 tons coal), 44 tons 3 cwts., a total of 114 tons 13 cwts. The drawings reproduced herewith show details of the design such as are required by model engineers, and the photographic illustration gives an impression of the general external appearance of the class. The engine No. 1097, is actually the prototype and has now, or recently had, nameplates over the driving wheel splashers inscribed "Immingham."

The publication of these details and illustrations was decided upon by the Editor to form another of the series of items specially asked for by readers of the MODEL ENGINEER.

(Detail drawings of the tender will be published with the next instalment of Railway Practice).



"Immingham" class locomotive, L.N.E.R.

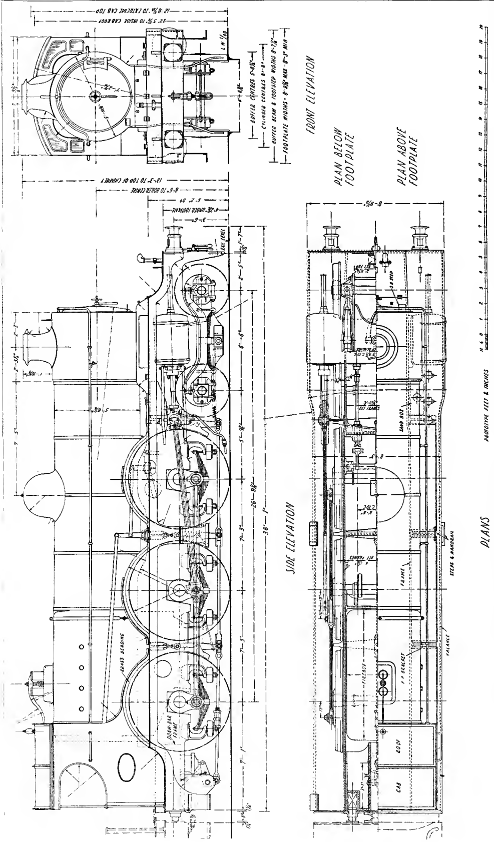
Vacuum Relief Valves

A Winchester reader asks for an explanation of the purpose of the fitting seen on many locomotives immediately at the rear of the chimney in a vertical position. He has noticed that in engines so equipped there is a noise as of a valve being opened when just in the act of starting, this noise emanating from the fittings referred to.

This is the vacuum relief or "snifting" valve used for the purpose of keeping the superheater elements cool when the locomotive is running with the regulator closed. These valves which communicate with the superheater header are kept closed by the pressure of the steam while the regulator is open when, of course, steam is circulating through the elements. When the driver shuts off steam the relief valves open and admit air to the superheater element tubes and as a consequence of this the tubes are cooled and the risk of their getting burned is obviated. In one arrangement each header carries two relief valves which are automatic in action. The seats are inverted and the valves fall away from the faces when the regulator is closed. The action of the steam when the regulator is opened and the valves are brought into contact with the seats is responsible for the sound referred to by the correspondent.

Locomotive "Refinements"

A Southampton reader, in a letter to the writer, expresses the view that as locomotives are now so much larger than formerly and are given increasingly arduous work to perform, the time has come when "some greater measure of refinement" in their design, particularly in respect of equipment, should be introduced. He instances more especially power reversing gear and mechanical firing. Both of these as he remarks, are labour saving devices and each does much to reduce the hard nature of the work performed by the enginemen and particularly the fireman who "in the course of a long run has to transfer from the



Elevation, end and part sectional plan drawings of 4-6-0 type express locomotive, " Immingham " class, L.N.E.R.

tender to the firebox an amount of coal the weight of which runs into tons."

As the writer himself knows from practical experience the fireman's lot on long runs with heavy loads can be a somewhat unenviable one, although to the experienced man brought up and trained to the job, the physical exertion is less trying than to the " amateur " who tries his 'prentice hand at firing. The introduction of mechanical stoking apparatus on locomotives built to the design and proportions common on British railways is considered inadvisable and when the cost of installation and upkeep has been taken into account, not justified by the character of the work to be performed. Such devices are certainly a great advantage where the fireboxes of locomotives are of such proportions that the coal has to be thrown a much longer distance and spread over a greater area than is the case here, and also where the class of coal burned is different and can be handled to greater advantage by mechanical than by hand operated methods. As regards power reversing, there have been numerous applications of steam and oil-hydraulic reversing gears on British locomotives, and these certainly assist the driver considerably in the work of reversing the engine. Compressed air operation has also been used but the majority of locomotives in this country are reversed by hand either by means of rack and lever mechanism or by wheel and screw. The operation of these gears is rendered easier by balancing the reversing shaft and by such refinements as the use of ball-races for taking the thrust of the screw in either direction, vacuum operated clutches and so forth.

THE "BAT"

(Continued from page 460)

wide, is cut across, and a small segment removed, so that when the cut is closed up the ring will enter the end of the barrel very tightly. The smokebox will then fit equally well over the piece of the ring which projects from the barrel, and will need no further fixing. Plumbers' jointing is used as a seal on the final erection.

For attachment to frames, cut two pieces of ¼ in. by 1/16 in. angle, each 5/16 in. long. These are riveted or screwed to the flat bottom of the smokebox, 3/16 in. from the front end, and 1/16 in. from each side, as shown in sketch. When the smokebox is in position on the frames, the bottom of it rests on the top edges of the frame plates, whilst the angles go down between them and are secured by a screw put through a clearing hole in frame, into a tapped hole in each angle. The position and shape of the holes in the bottom of the smokebox, for allowing the steam fitting and the blastpipe to pass, should be obtained by measurement from the actual job.

Smokebox for Water-tube Boiler

The forward extension of the boiler-casing beyond the end of the inside barrel really forms the smokebox of the water-tube boiler, but we shall need a support for the front end, and also a front plate. About the simplest way to fix the whole lot is to use an additional outer wrapper of sheet metal, with a push-in front. Bend a strip of thin metal, say about 24 gauge and 1½ in. wide, around the barrel-finishing off the bottom to the same shape as the loco-type smokebox shown in sketches ; but bring the parallel part in close enough to fit between the frames, and drop about 3/16 in. below them when the smokebox is at proper boiler height. Also let the edge of the wrapper overhang the front edge of the boiler casing by 1/16 in.

Next cut a piece of 1/16 in. sheet metal to the shape of the front of the wrapper, same as used on the loco-type front, but leaving it a little larger. Cut a ring of the 1¾ in. boiler tube about 3/16 in. wide, and take a piece out of it, so that when the cut is closed it will be a tight push fit in the end of the boiler shell. Then silver-solder it to the front plate. Push the plate into position, with the ring inside the barrel as far as it will go. Mark off the outline of the wrapper on the front plate, remove, and file to shape, so that when the front is in position with the ring inside the barrel and pushed fully home, the front plate lies nicely in the recess or rebate between the outer wrapper and the end of the circular barrel. (See sketch.)

Dummy Door and Hinges

The door and hinges on this smokebox front are only dummy ; there is no need for a real hinged door when the complete front comes out with a pull. The wrapper can be attached to the smokebox barrel by a couple of 1/16 in. countersunk screws through the lot, at each side near the bottom. When the boiler is finally erected, the front end is secured by a couple of 1/16 in. screws, through the frame and the pieces of the wrapper passing down between them. Clearances will need to be filed to clear the lubricator drum and the cross steam pipe. Holes for steam and exhaust pipes are measured off, marked and drilled in the lower part of circular barrel, as there is no flat bottom to this variation. Chimney and liner are made and fitted exactly as described for the loco-type boiler.

A No. " 1 " gauge Drummond tank built by Syd. Dawson, of " blobs and gadgets " fame.

*A Sensitive Drilling Machine

Describing how a useful item for the workshop was constructed as the result of an urge to "make something"

By W. L. Rowson

THE lever-link, Fig 12, connecting the lever to the top of the pillar comes next, and is of $\frac{1}{2}$ in. square bright mild-steel, followed by the lever and handles, Figs. 13, and 14. These are straightforward jobs, the former of $\frac{1}{4}$ in. by $\frac{3}{4}$ in. bright mild-steel and the latter turned from $\frac{3}{4}$ in. diameter bar and screwed together. Also, make and fit the small $\frac{1}{4}$ in. screwed stub (Fig. 15) at the rear end of lever for anchoring the return spring.

Next take in hand the thrust housing Fig. 16. This can be turned from 1 in. steel bar. Chuck a suitable length, bore out and thread $\frac{5}{8}$ in. by 26, remove and mount on a screwed stub-mandrel, and turn the outside diameters. The slot for the lever can be milled at the same setting, or, if you have no milling attachment, a satisfactory job can be made by careful hacksaw and file work. The thrust retainer, Fig. 17, can be turned from the solid bar, bored, reamed, externally screw-cut and parted off at one setting. The adjustable depth collar, Fig. 18, should next be made, followed by the two small thrust-retaining keys, Fig. 18a. Chuck a piece of $\frac{5}{8}$ in. mild-steel, turn down a short length to 9/16 in. full, drill $\frac{3}{8}$ in. and part off $\frac{1}{8}$ in. long. Saw this ring in half, trim off any burrs, and case-harden. To assemble, slip the depth collar over the chuck spindle followed by the thrust retainer, having previously put on the remaining locking-ring, place in position in the annular groove the two small semi-circular keys, put a 5/16 in. steel ball in the countersink of the spindle end, pack the housing with grease and screw on. Adjust with just a little end-play and lock in position with the C spanner. Connect the lever-link to the pillar and the link to the lever, and then the lever to the thrust, and see that everything works freely, but on no account sloppily. Careful turning and fitting of these parts will be well repaid when the drill is in use; in fact, this applies to the whole machine.

* *Continued from page* 424, "*M.E.*," *April* 25, 1940.

Next take the jockey pulley gear. Fig. 20 is the fixed arm already referred to, and is turned from $\frac{5}{8}$ in. square mild-steel and slotted for the adjustable arm, Fig. 21. This is from 1 in. by $\frac{1}{4}$ in. flat mild-steel, and is again largely hacksaw and file. The pulley cross-shaft, Fig. 22, is turned from 9/16 in. round bar and brazed in position in the adjustable arm. The jockey pulleys (two), Fig. 23, are cast-iron and plain turning jobs. It is worth while obtaining a close running fit with these on the shaft or they will soon become noisy when in use. They are retained on the shaft by a washer and split-pin. The small saddle, Fig. 24, is slipped on the jockey-pulley fixed arm before screwing into the pillar. The locking-bolt and lever, Figs. 25, 26 and 27, are simple jobs. The whole of this part of the machine can now be assembled, and, after making the spring-adjuster, Fig. 28, and the locking-screw, Figs. 29 and 30, a suitable spring connected from adjuster to lever. What is required is an expansion spring about 2 in. long that will comfortably extend to 5 in. without losing its tension. The one fitted to the writer's machine is 2 in. long by $\frac{1}{2}$ in. diameter close-wound coils of 18 gauge wire. This can be adjusted to lift the chuck immediately on removing the hand from the lever. Some people prefer a weight to return the lever, but, personally, after trying both, the writer finds a spring more satisfactory. A weight can, of course, easily be fitted if desired.

We now come to the swivel-arm, Fig. 31, carrying the canting-head for the table or vice. This is turned from $1\frac{5}{8}$ in. square bright mild-steel, and entails quite a lot of interesting setting-up, hacksawing and turning. (Did I hear someone groan?) It might be said here that if anyone prefers pattern-making to hacksawing, this part and the pair of arms, Fig. 5, can quite well be castings. It would be necessary to increase certain dimensions slightly—namely, the thickness of the wall around the pillar and the ball-race housing walls in Fig. 5. The centre

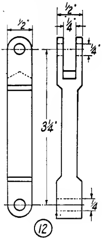


Fig. 12. Lever link.

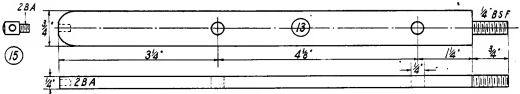


Fig. 15. Stub for anchoring spring.

Fig. 13. Lever.

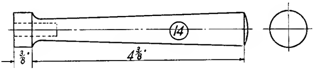


Fig. 14. Lever handle.

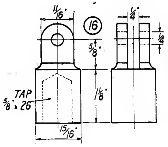


Fig. 16. Thrust housing.

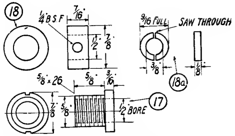


Fig. 17. Thrust retainer and adjuster.
Fig. 18. Depth collar.
Fig. 18a. Thrust retaining keys.

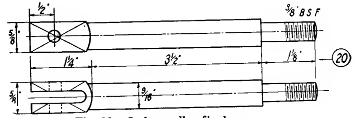


Fig. 20. Jockey pulley fixed arm.

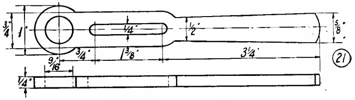


Fig. 21. Jockey pulley movable arm.

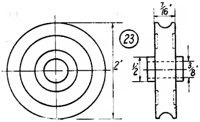


Fig. 23. Jockey pulley.

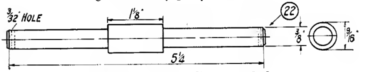


Fig. 22. Jockey pulley cross-shaft.

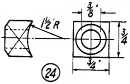
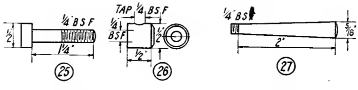
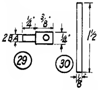


Fig. 24. Saddle.



Figs. 25, 26 and 27. Jockey pulley locking bolt, nut and lever.



Figs. 29 and 30. Locking screw for spring adjuster.

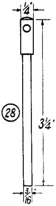


Fig. 28. Spring adjuster.

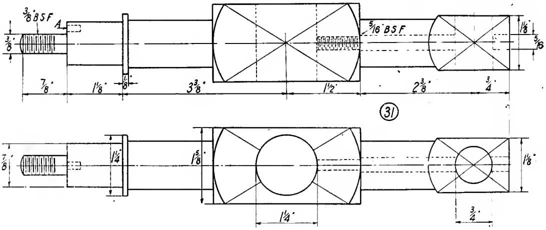


Fig. 31. Swivel arm.

part of Fig. 31 would have to be altered; also the $\frac{3}{8}$ in. screwed end to this part would, of course, be a steel stud screwed in. If anyone cares to work this way, it need not impair the utility or appearance of the machine. Take your choice—pattern-making and no hacksawing and filing, or hacksawing and filing and no pattern-making. To return to the all-steel method. After setting out part Fig. 31, mount on the faceplate and bore the central hole for the pillar, saw away as much surplus material as you can and finish the squared end, then mount between centres and turn to the sizes given; finally, drill and tap the hole for the clamping-bolt. If the size of this part is not within the capacity of the lathe available, it can be made in three parts and screwed and pinned together. For the centre portion use a 3 in. length of $1\frac{5}{8}$ in. square B.M.S.; mount this on an angle-plate on the faceplate and bore and screw the holes for the arms, chamfer the corners, reverse and repeat the chamfer, then mount direct on the faceplate and bore the pillar hole. Use the same bolting face for both positions, then the two holes should come out square with each other. The arm for the fixed table can be turned between centres out of $1\frac{1}{8}$ in. square steel and the other one from $1\frac{1}{4}$ in. round steel.

(To be continued)

Brazing Metals with Silver-Solders

By A. J. T. Eyles

THE mechanical strength of silver-solder brazed joints depends entirely upon the nature of the solder used, the depth to which the solder penetrates, the temperature at which the brazing is done, the thoroughness with which the metal surfaces to be joined are cleaned, the correct manipulation of fuel flame, and the proper uses of suitable fluxes.

The process of brazing with silver-solders can be applied successfully to brass, bronze, copper, monel, nickel iron steel (including stainless steel), or combinations of these metals. The fundamental advantage of silver-solder is the freedom with which it will melt and flow into joints to form a close neat joint, the strength and reliability of

Fig. 1. Various shapes and sizes of component parts silver-brazed, and silver-brazing semi-circular coils to a cylindrical component.

which exceeds that of soft-soldered or spelter-brazed joints.

Silver-soldering is thought by many model engineers as expensive, whereas for many working models it will prove an economical method because of the quick free-flowing properties of the silver-solder, the sparing way in which it can be used, and the fact that joints thus produced require very little finishing. In fact, it is actually the cheapest method of making many of the joints required in model making, where superior strength, neatness, ductility, leakproof joints and resistance to bending stresses, vibration and corrosion are primary considerations.

Silver-solders are made in strip, wire and granular form, and in a number of different grades of fusibility, the melting points of silver-solders varying between 1,163 degrees and 1,600 degrees F., according to the percentages of silver, copper and zinc they contain. A modern low melting-point silver-solder known as "Easy-Flo" has a melting point of 630 degrees C. (1,163 degrees F.). The tensile strength of silver-solders varies from 40,000 to 60,000 lb. per sq. in.

Too much care cannot be taken in preparing metal surfaces to be brazed. Although a good flux will dissolve films of oxide during the brazing operation, it is necessary to start with clean surfaces. Metal that is clean is much more likely to make a strong sound joint than when impurities are present. Various methods of cleaning may be employed, such as filing, scraping, grinding, machining, etc. The joints should be smooth and they should fit closely; the parts should be held together firmly while the brazing operation is being performed. Silver-solder is remarkably fluid when in a molten state, and penetrates

(Continued on page 469)

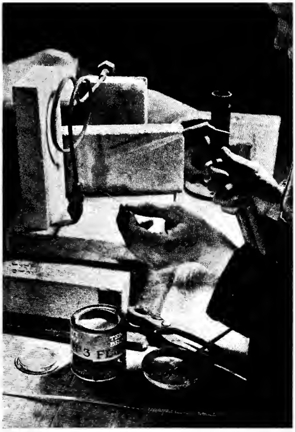


Fig. 2. Silver-brazing a coiled copper tube in a bronze fitting.

Model Engineers and National Service

* Multi-tool lathes

By Edgar T. Westbury

FOR the production of a very wide variety of workpieces of the smaller nature, the No. 0 " Maxicut " lathe, with its hydraulic and automatic features, has proved extremely popular both in this country and abroad. This machine, which has one capacity only, of 6 in. by 12 in., may be seen operating on such components as automobile stub-axles, pistons, layshafts, gear-blanks, projectiles steam fittings, etc. As in the case of the No. 1 " Maxicut " lathe, described previously, the object of this machine is to bring a number of cutting-tools into use simultaneously so that the component may be turned on all diameters, faces, shoulders, tapers, undercuts, etc. in one cycle of operations, thus dispensing with a series of separate operations on different machines, and the resultant loading and unloading times.

The No 0, in conformity with present-day practice, is heavily constructed throughout to withstand the strains set up by a multiplicity of cutting-tools, as will be observed from Fig. 9, and is self-contained, with an electric motor mounted on a bedplate at the rear. The motor drives the pulley-shaft through a multi-strand texrope belt, and, from this shaft, the drive is conveyed through a heavy duplex silent roller-chain to the clutch housing at the front of the machine. (" A," Fig. 9.) The roller-chain is totally enclosed, and runs continually in an oil-bath. The clutch, operated by the lever " C," is of the double multiplate type; one side engages the drive, whilst the other engages the spindle-brake for quickly bringing the spindle to rest at the completion of cut. From the clutch spindle, an enclosed silent chain (" B," Fig. 9) drives direct to the main spindle, providing one speed only, as this is found to be sufficient provision for the class of work applicable to multi-tooling.

The speed can be varied easily, however, when setting up, by substituting chain-wheels having a different ratio on the final drive to the main spindle, and, by this means, any one speed from 30 to 650 r.p.m. may be obtained.

The spindle is hollow, mounted in heavy Timken tapered roller-bearings, and carries a flanged nose to facilitate fitting special work-holding fixtures.

Perhaps the chief point of interest on the No. 0 " Maxicut " lathe is its unique hydraulic-feed system, embodying independent feed-pumps for front and rear slide feeds. One of the difficulties with hydraulic operation is that the constant flowing of the hydraulic oil causes it to heat up and thus reduces its viscosity, with the result that, whilst it will give a certain performance when the temperature is low on starting the machine, this performance is gradually reduced as the work progresses, and the operator has frequently to make adjustments to maintain the desired functioning of the machine.

* *Continued from page* 404, " *M.E.*," *April* 18, 1940.

Hydraulic Feed Pump Controls

To overcome this drawback, and thus make the performance of the hydraulic cylinders constant at all times irrespective of the viscosity of the oil, a special arrangement of pumps is introduced, comprising a main pump, driven from the pulley-shaft, which pumps oil from the sump to two special feed-pumps located in the housing seen on top of the headstock. A close-up view of the housing and the pump controls is shown in Fig. 10. These pumps are of the eccentric-vane type, with the degree of eccentricity adjustable from zero to maximum, and the rate of feed to the tool-slides is dependent directly on this adjustment. When it is required to vary the rate of feed to the saddle, the left-hand knob over the headstock

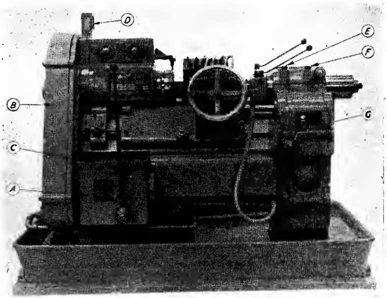


Fig. 9. The No. 0 " Maxicut " lathe, for work up to a maximum length of 12 in. and 6 in. diameter. Equipped with hydraulic feed system.

is rotated until the dial registers the required rate of feed. The graduations give the feed in .001 in. per revolution of the spindle, and, being directly connected to the spindle, remain correctly set for any spindle speed. The shaft carrying the knob has a small pinion to rotate the dial, and also carries a worm which engages with the quadrant on the moving portion of the feed-pump; by turning the knob, the quadrant is caused to rotate and thus vary the eccentricity of the pump.

In many cases, workpieces require turning down a face of considerable size by the rear slide tools, or require a deep undercut to be performed. In such instances, it is desirable frequently to reduce the rate of feed of the rear slide tools as they approach the forward stop, and on

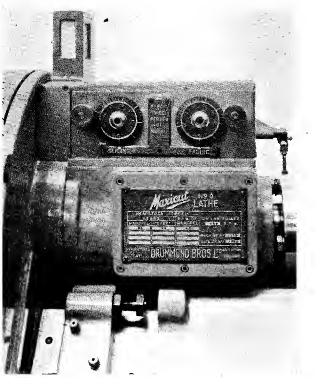


Fig. 10. Headstock housing of No. 0 " Maxicut " lathe, showing control dials of pumps operating sliding and cross feeds.

the No. 0 " Maxicut " this is effected automatically as follows.

Rear Tool Slide

The cam " A," Fig. 11, is clamped to the rocking-bar " B " carrying the rear tool slide, which rotates slowly, swinging the tools forwards into the workpiece. As the cam is carried round, it lifts the link " C " at a predetermined point in the cycle; this swings a cam over on shaft " D " and pushes the shaft carrying the adjusting-worm forward, thus partly rotating the pump quadrant and the adjustment of the feed-pump to reduce the feed. The amount of reduction is set by extending or shortening the link " C " and the point at which it operates by adjusting the position of the cam " A " on the rocking-bar. The pump-setting is returned to that originally set on the feed dial when the tools return to their starting position after completing their cutting operation.

Front Tool Slide

Fig. 12 shows the construction of the front tool slide on the No. 0 " Maxicut " lathe. It will be noticed that, in this instance, the machine having only one capacity (12 in. between centres), only one tool slide at each front and rear is permissible. A feature of the front slide, however, is its design to ensure the highest order of rigidity. The slide base is cast integral with the saddle, which has a length of 23¾ in. bearing on the bed-ways; this not only reduces wear but also helps to avoid the possibility of chatter. The bed-ways are of the characteristic " Maxicut " form—i.e., steeply inclined, so as to increase to a maximum the resistance to the strains set up by the cutting-tools. This feature also assists chips, etc., to fall readily into the pan, thus avoiding possible damage to the accurate surface by foreign matter.

The saddle-feed is operated by the hydraulic cylinder seen at "A," Fig. 12, which pushes the saddle towards the headstock until it makes contact with the adjustable stop " B." The return stroke is limited by the adjustable stop-bar " C," which has two locknuts on the guard side of the stop-block. It is the standard custom to feed the front tools into the work by hand, after loading the workpiece, hence the provision of the large handwheel " D," mounted on a square threaded bar engaging with a nut on the top slide. A fine thread adjustable stop, to determine the forward position of the tools, can be seen at " E," and a micrometer disc is located behind the handwheel to permit of fine setting when tooling the machine. The illustration shows a slide fitted with two tool-blocks each carrying two tools; but any number of tools can be fitted, up to the length of the tool-block base, which is 7½ in. Incidentally, this view shows the method of providing fine adjustment to the tools for setting up the machine for a new job or after grinding the tools. Each tool is held in the block by three screws as at " F," Fig. 12, whilst a fourth screw holds a small block " G," having an adjustable screw which bears up against the rear of the cutting-tools.

To permit of maintaining continual accuracy after long periods of heavy duty, all slide-ways on the saddle and tool slides are fitted with gib-strips, which may be tightened as require to remove any suggestion of side-play on the ways.

We have already shown the rear-slide arrangement in Fig. 11, from which it will be observed that the feed is in the form of an arc as the tool base is carried round by the rocking-bar " B." The base (which varies from 4 in. to 10 in. in width) is clamped to the rocking-bar, and may be adjusted along same so as to cover the work. The method of operating the rocking-bar is by a second hydraulic cylinder located within the bed casting and pivoted at its base; the piston-rod then connects to an arm extending from the rocking-bar behind the panel " G." Two screws will be observed at " E " and " F " ; these

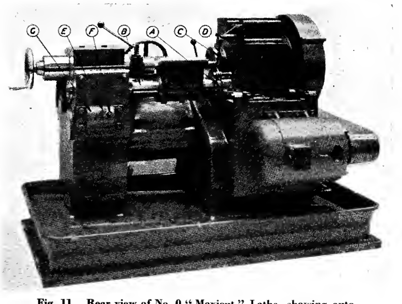


Fig. 11. Rear view of No. 0 " Maxicut " Lathe, showing automatic cross feed control gear.

are the limit-stops for the rear slide. The arm abuts against the screw " E," determining the forward position of the tools, whilst the bolt " F," attached to the arm, carries two locknuts, which are drawn in against the casting on the return stroke, thus determining the rearward position. It is important that these stops, together with the corresponding stops on the front slide, are adjusted carefully, so as to avoid all unnecessary movement, as it will be appreciated that any surplus movement represents unproductive time, and it is a feature of the " Maxicut " lathes that floor-to-floor turning times on a very wide range of components can be reduced much below those obtained with any other form of production. It is only when every second per piece is saved that the maximum benefit is derived.

We have referred to the feed control on the headstock and the operating cylinders to the front and rear slides. It will now perhaps be of interest to describe how the pressure-oil is transmitted to the slide cylinders.

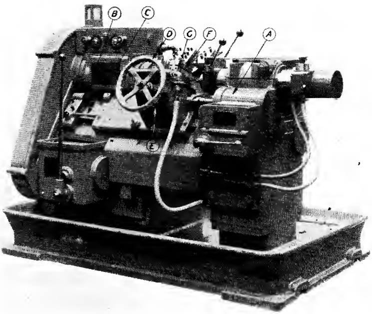


Fig. 12. Front of lathe showing details of front tool slide equipment and control gear.

Hydraulic System Layout

The main pump, which is driven by the motor and continues to run when the main spindle is stationary, draws oil from the sump and supplies it constantly to the two feed-pumps, the multiple main-control valve, the multiple valve for the tailstock (when hydraulically operated) and to the quick-approach valve. When the spindle is stationary, the surplus oil from the main pump passes through a relief valve (not shown) direct to the sump.

On closing the clutch to start the spindle, and moving the main-control valve, seen at " G," Fig. 9, to the feed-in position, the feed pumps supply oil to the saddle and rear-slide cylinders, causing the pistons to move forwards. As the quick-approach valve, operated by a cam on the rocking-bar, will be open for the commencement of feed, the rate of the rear-slide piston will be increased by the additional pressure-oil, provided direct from the main pump, until the cam on the rear-slide rocking-bar closes this supply. The pistons will continue to move at their respective rates of feed until the slides reach the stops. At this point, the by-pass valves will open to allow the oil from the feed-pumps to pass directly to the sump.

(*To be continued*)

Brazing Metals with Silver-Solders

(*Continued from page* 466)

interstices that ordinary brazing-spelter would fail to fill. Only a film of silver-solder is needed usually to give a strong sound joint.

In order to protect the metal or metals against oxidation, and to increase the free-flowing properties of the silver-solder, it is essential that the proper flux be employed. Although borax is the best and most reliable flux for silver-brazed joints, it is generally most satisfactory when applied in the following ways: (1) dissolve borax in hot water, making a saturated solution, and apply while hot to obtain an evenly deposited coat; (2) mix calcined borax and clean water to make a creamy-like paste. A flux composed of equal parts of borax and boracic acid made into a paste with a saturated zinc chloride solution is much better than borax alone for brazing stainless steels. A very efficient proprietary flux to use in silver-brazing stainless steels brass, bronze, copper, etc., is known as " Tenacity Flux No. 3."

Broken coke, asbestos nuts, firebrick, etc., are very serviceable to support the metal parts under the blowpipe or blowlamp flame and also to retain the heat in the area of the joint. Asbestos sheet shields or firebricks should be suitably arranged to avoid draughts and to concentrate the heat of the flame upon the joint during the brazing operation. The source of heat should be continued long enough only to cause the silver-solder to flow freely. Prolonged heating does nothing but oxidise and weaken both the metal and joint material. When metal parts have been heated to slightly higher temperatures than the flow-point of the silver-solder, the flame should be quickly removed and the silver-solder applied to the joint. If the metal parts have been properly cleaned, fluxed and heated, the silver-solder will instantly flow into the joint. As soon as the joint is completed, remove the residual flux. If an excessive amount of borax flux has been used, it is extremely difficult to remove the vitreous film formed by scrubbing or washing. When special brazing fluxes of the " Tenacity " type are used, the flux residue can easily be removed by plunging the brazed job in cold or warm water and scrubbing with a brush.

A Nut-Retaining Tool

By W. M. Halliday

MOST wireless engineers and model-making mechanics will undoubtedly appreciate the useful features of the little tool here illustrated, because of the readiness it permits difficulties in the matter of checking the turning action of a nut to be overcome.

In making and repairing wireless sets, in the manufacture of toys and mechanical models, it is often required to clamp together pieces, plates and the like, and employing for this purpose an ordinary square or hexagon nut on a small set-screw. Difficulties are very often encountered in preventing the nut from turning round with the screw as this latter is being tightened either by screwdriver or spanner.

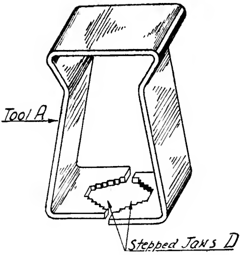


Fig. 1. Perspective sketch of the nut-retaining tool.

Usually, a pair of pliers, or a small spanner are used for this purpose, but only in situations where space will permit their entrance. Unfortunately, in the instances mentioned—i.e., model making and wireless construction, as well as numerous other similar work—space is prohibitive, with the result that other means have to be provided to overcome this trouble.

The drawings show a very simple but most effective little device, designed and adopted by the present writer, for use chiefly in connection with model building, which has proved exceedingly useful and handy.

The tool A, shown in Fig. 1, consists simply of a piece of flat spring steel shock, $\frac{3}{8}$ in. wide by 0.025 in. thick, and about 10 or 11 in. long. The stock should not be softened, as this is not necessary if carefully handled when being bent. It should be formed to the outline indicated. It will be seen that the two lower or open end jaws are so shaped as to allow them to overlap each other, as shown. Each of these two jawpieces are provided with a vee-shaped gash, the slant sides of which are stepped. These steps should be made fairly shallow—not more than 1/32 in. deep, for instance, as much more than this amount is apt to result in the jaws buckling over when meshing with the sides of a nut being held.

The Tool in Use

Fig. 2 illustrates the method of using this tool. Two plates are being clamped together in this case, a round-head screw C being employed, and a hexagon lock-nut of standard pattern used for locking plates on the screw.

The tool A is placed in position with the vee-gashed jaws at the lower end embracing the nut, the tool easily being opened to permit placing it in position on the nut. By closing the left hand, sufficient pressure will be exerted on the jaw portion to hold the nut firmly from turning whilst the screw is being turned by means of the screw-driver, as shown.

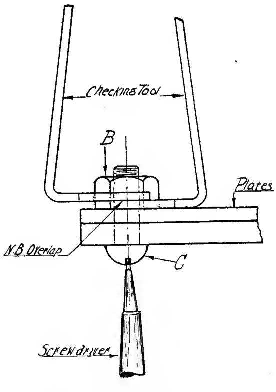


Fig. 2. Method of using the tool.

In the case of larger nuts being handled the tool may be made appropriately larger, but the writer has found this a most convenient size, as it covers a good range of nut sizes such as are likely to be met with in model-making, wireless and clock-repairing activities, and is well recommended for facilitating an otherwise awkward operation.

*Gauges and Gauging

A series of great value to engineers of all classes

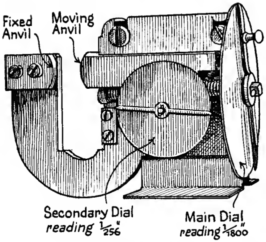
By R. Barnard Way

The Measuring Machine

DURING the course of these articles we have read a great deal about measurements certified as accurate to limits first of the one-thousandth part of an inch, then the ten-thousandth, and after that the hundred-thousandth. Unimaginably exact to the layman, such measurements really are made every day, and made with certainty and precision. Getting them out is a skilled job too, though the modern apparatus designed for the work gives even the semi-skilled hand a fair chance at achieving equal accuracy.

The use of standard gauges with freedom in the shops means that they will be subject to a good deal of wear. They must, therefore, be continually checked as to their dimensions, and unless some final measuring device is at hand, capable of making a decision at least ten times as accurate as that of the best micrometer gauge in the shop, we shall soon be in difficulties.

The need for such machinery has been felt since the days of James Watt, at least, and probably much earlier, going back into the 17th century. Curiously enough, the Vernier was devised, not for measuring physical objects, but for heavenly bodies. We hear that the great astronomer Huygens first used it as far back as 1659. Various inventors, amongst them William Gascoigne, a Yorkshire astronomer, contributed improvements. It is claimed that his device was in use in 1639, and that he could by its use, divide a foot into "above 40,000 parts." It could be carried in the pocket.

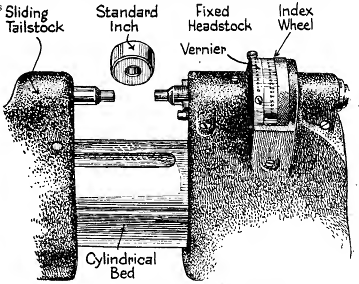


A historic piece : James Watt's original end measuring machine.

We have not much room here for historical surveys now, but the writer has to admit that his personal prejudices are all in favour of discovering a British inventor's name, where possible. Propaganda is supposed to be the thing, these days, so let us have just a little of it, especially where we can show that a British inventor's name should be honoured, too, in pioneer work.

James Watt must have been driven to distraction sometimes by the impossibility of getting accurate workmanship in his engine building. He had the best workmen of the day, but very little in the way of good machine tools. The roughest work we turn out today would have pleased him—from the accuracy standpoint—in the early days at Soho. In order to get some standard of accurate measurement into the shops, he devised a measuring machine, able to register a movement of the gauging spindle of 1/1800 inch. It is extremely doubtful whether such a degree of accuracy could ever be applied in his workshop, but the gauging dial was graduated to read inches in 256ths.

Like all measuring machines, or nearly all, Watt's device depended upon a fine screw. Now a screw, to be of any service for measuring purposes must be accurate in every respect, both as to its pitch and contour. Contrary to what most mechanics might believe, an accurate screw is about the most difficult thing to produce in all workshop practice. Until the advent of the machine-tool age, this did not matter so much, but now it is a different matter altogether. As we shall see presently, the contour of the average machine-cut screw is not invariably perfect by a long way, while that of the die-cut thread is frequently horrible, no less.



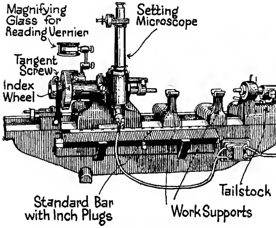
A detail of the P. & W. super-micrometer.

Accurate screw threads are produced now by grinding, but even so it is difficult to make one that can be relied upon for absolutely smooth running in and out of its nut. To determine its accuracy you must have measuring devices of at least equal accuracy, and so we get something like a vicious circle in action. These methods belong to our next instalment, so we will not consider them here, being satisfied for the moment that measuring screws are difficult to produce. How much more difficult it must

* *Continued from page* 427, "*M.E.,*" *April* 25, 1940.

have been for James Watt then, to make an accurate screw, having 18 threads to the inch. He did it, and though we have not seen the machine, it undoubtedly exists, as we have a photograph of it. As a worthy example, a drawing is included for comparison with later machines.

Maudslay, the father of the modern machine tool, put the measuring machine on to a firm footing, making several that were capable of recording the ten-thousandth part of an inch, as far back as the early years of the 19th



The P. & W. measuring machine.

century. But for sheer brilliance, his pupil, none other than the great Joseph Whitworth, outshone all with the machine exhibited at the Great Exhibition of 1851.

This really was a triumph, equalling anything produced today. He was able to demonstrate that the millionth part of an inch was a real dimension that could be recorded, though it was before its time, no doubt, as far as workshop practice was concerned. Where it was of value, undoubtedly, was in the making and calibration of national standard bars.

The great difficulty in making end measurements with such precision is in deciding when a true contact is made between the measuring anvils and the specimen. You know, if you are in the habit of using micrometer gauges, especially of the vernier sort, that this is a real difficulty, for you can almost always screw up the thimble a little tighter. It is for this reason that the ratchet stop was devised. With a measuring machine having a dial, or index circle, 5 in. in diameter, driven by a tangent screw, such a difficulty will be magnified a thousand times, and something less fallible than the ratchet stop must be provided. Whitworth introduced the sense of touch.

In between the end of the specimen to be measured and the measuring anvil at one end, he inserted a small bar, one inch in thickness. This could be held up without other support than the frictional grip due to the pressure exerted by the lead screw. If this pressure was eased off enough to allow the bar to slip down, but not fall out, it was considered that contact was established.

To demonstrate this fully at the exhibition, Whitworth had a bar, a replica in steel of one of the British standard yard bars, set up in between the measuring anvils. The lead screw was adjusted until this condition was established, and then he showed how the heat of his hand encircling the bar—without touching it—expanded it enough to hold the gravity piece so that it was clipped sufficiently tightly to prevent its dropping out. Knowledge of the physical characteristics of the standard bar proved that its length had not increased more than by 0.000001 in.

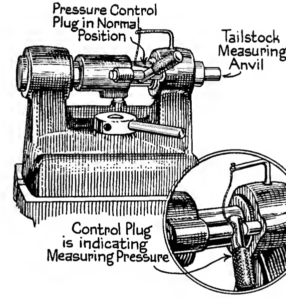
In a lecture given during 1856, this remarkable man said that the workmen in his Manchester shops found that it was easier to work to the one ten-thousandth of an inch, using end measurements from his machine, than by trying to gauge hundredths from a steel rule.

It would seem that such a degree of perfection could hardly be improved upon, even in our day. Quite frankly, it cannot, but modern methods of manufacture have made it possible to produce such devices so that they can be put into every workshop, though it must be said they are not cheap to instal.

We can briefly review one or two of the more commonly seen machines, though they are not so frequently met with as such an expression might indicate.

There is one made by Pratt & Whitney, called a Super-Micrometer, for general shop use, but the degree of accuracy claimed for it extends only to 0.0001 in. The writer has handled this machine often enough, it is, in effect, a micrometer gauge with a large index wheel with vernier. The size of the graduations makes for very easy readings. The index wheel is, in effect, a nut that moves the spindle in, or out against the pull of a tension spring of a strength sufficient to impart a nice "feel" to the working, as well as to absorb all suggestion of backlash.

The micrometer screw has 20 threads to the inch, and is only $1\frac{3}{4}$ in. long, so an arrangement must be provided to set the jaws to an exact number of inches of separation before a measurement is taken. The index wheel being set to zero, an approximate measurement is made of the specimen to discover the number of inches that will enclose it. The tailstock is then brought along on the bed by means of a rack and pinion, and the gap between its anvil and that of the headstock is adjusted by means of an appropriate number of cylindrical steel standard inches.



The P. & W. system of measuring pressure indication.

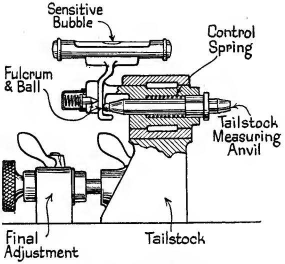
A channelled bar is provided to support these at the correct height. These standard gauges being removed, the specimen is placed between the anvils and the measurement is made in the ordinary way, no special device being necessary for the judgment of contact.

The real measuring machine made by the same firm is of a more complete description, and is designed to measure, with precision, down to the nearest hundred-thousandth.

Here we have got a contact device to ensure that the judgment of the true measuring pressure is not left to the operator, but to the machine. In principle it is like that of the Whitworth machine, but a little more sensitive.

Here is a sketch of the whole machine. As with the super-micrometer, the screw is only $1\frac{3}{4}$ in. in length, but it has 25 threads to the inch. The index wheel is 4 in. diameter and has 400 clear graduations, so that for a start we have an instantly read 0.0001 in. Each of these graduations covers 0.03 in., so there is adequate spacing between them. The addition of a vernier puts in another decimal place giving us that 0.00001 in. as the regular class of indication.

Setting the gap between the measuring anvils is done by reference to a standard bar, seen running along the length of the bedplate. Inset into this bar are highly polished plugs, each bearing a reference line engraved, with as near perfect precision as is humanly possible, so that they are at one inch intervals. The reference lines are not ordinarily visible, so fine are they, and so a microscope, having an illuminated hair line across its field, must be used to ensure setting the headstock truly to any required



The Newall system of measuring pressure indication employs a sensitive bubble level.

gap. A fine screw adjustment is provided to make the final setting.

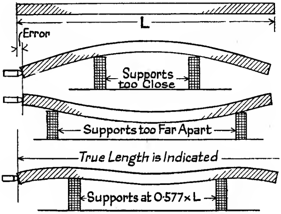
To get the unvarying contact between the ends of the specimen and the measuring anvils, the anvil in the tailstock is held up to its duty by a compression spring. When not at work, the pressure of this spring is sufficient to clip a polished round plug between two hardened and polished steel jaws, in a horizontal position. When a measurement has to be made, the pressure from the movement of the screw tends to relieve the pressure that clips this plug between the jaws, and at a precise moment the plug slips down to an almost vertical position, without, however, falling out. At this point, it is decided that true contact is made, and the reading can be taken off the scale.

For fine adjustment of the index circle, a tangent screw is provided, and a magnifying glass assists in reading off the final figures, the graduations being scribed with extraordinary fineness.

It is claimed that with this machine the difference between the positions of the indicator plug represents a matter of not more than 0.000002 in.

The Newall machine is a British product, with original features of interest, the precision claimed for it is the same as for that of the Pratt and Whitney, but the nature of the contact governing arrangement allows estimation almost to the one millionth part of an inch.

The dividing screw has a buttress thread, an original feature not seen in other machines, and the index wheel has the large diameter of $6\frac{1}{2}$ in. The screw has 20 threads to the inch and there are, therefore, 500 graduations on the

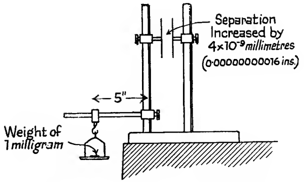


The proper placing of supports for end measurements.

wheel rim. A vernier is fitted as with all similar machines for the final reading.

The most interesting feature, however, is in the contact device in the tailstock. The anvil is held up to the end of the specimen by a compression spring, and its rear end protrudes through the casting. A spirit level with a very sensitive bubble is supported in such a way that it is tilted slightly by movement of the anvil, a magnifying lever arrangement ensuring that the minutest movement is passed on to the bubble.

It only requires pressure enough on the anvil to compress the spring, and the level tube is tilted. Graduations on the tube show what the movement of the bubble represents. We saw, some way back in this series, how the sensitive bubble could be used in this way, here then is another adaptation of the same idea.



The last word in measurement of small distances.

When dealing with long specimens, in such machines as these, there is always a risk that, unless they are correctly supported, they may sag under their own weight. The periodical testing of the national length standards has to be done under the most strictly controlled conditions, and this sagging effect is always an essential part of the precautions that are taken. That it did happen was realised long

ago, and various theories were advanced to deal with it. Sir George Airy, the Astronomer Royal of the day, worked out a spacing for the two supports that would permit the bar to sag, in such a way that its effective length would not be reduced. He decided that if the supports were separated by 0.577 of the length of the bar, and spaced symmetrically, then all would be well. This is the accepted arrangement always adopted, and is worth bearing in mind when measuring the length of any long rod or bar. No matter how stiff the section may be, there is inevitably a tendency to sag, which will most definitely upset the measurement if it is to be carried to the extent of only the ten-thousandth part of an inch.

A sketch is added here to explain the basis of this argument, showing, in grossly exaggerated form, the way in which the sag shortens the length.

As a finish to this article, here is a measuring device, capable of registering a movement of less than half of one hundred millionth of a millimetre! Known as Whiddington's ultra-micrometer, after its inventor, it consists of two pillars, each carrying one plate of an electrical condenser. Separation of the plates of this condenser produce fluctuations in a high frequency circuit, coupled to a radio amplifier of superheterodyne type. The drawing shows the arrangement. A weight of only one milligram hung at a radius of 5 in. from one of the pillars, produced a calculated separation of 0.000000004 millimetres, and this was duly noted by an observer wearing headphones, for the record is made by sound.

Whether such a system can be adapted for purposes of measurement remains to be seen, there would appear to be distinct possibilities in it. The amplification without distortion of the minutest changes in electric current flow to an unlimited extent is an easy matter these days.

(To be continued)

Reports of Meetings

The Islington Model Engineering Society

It is hoped to hold an open night in the near future, the date of which will be announced later, in aid of the local church. Work has been started on the Society's new workshop. New members are always welcome, and full particulars may be had from the Hon. Sec., T. H. BRIGGS, 39, Blandford Street, Baker Street, London, W.1.

Bournville Model Yacht and Power Boat Club

We propose holding a power boat regatta as usual on Whit Monday, May 13th. The programme will be on the usual lines and will include :—(1) Steering Competition—A. Hackett Trophy ; (2) Nomination Race ; (3) 300 yards race 15 c.c. engines ; (4) 500 yards race 30 c.c. engines—Coronation Speed Trophy ; and is due to commence about 3 p.m. Hon. Sec., A. H. HARLOW, 88, Langleys Road, Selly Oak, Birmingham, 29.

Altrincham Model Power Boat Club

The next general meeting will be held at the A.S.E. Club and Institute, High Bank, Durham Road, Altrincham, on Thursday, May 16th, at 8.0 p.m., when it is hoped to be able to announce the date when the lake will be ready for use again. Hon. Sec., O. B. BATES, 2, Hereford Villas, Hereford Street, Sale.

Mancunian Model Engineering Society

At the annual general meeting on April 26th, we had on view two very well-made models. One was a tender for a 4-4-0 L.M.S. compound by Mr. H. Kelly, and the other was a 50 in. Marblehead sharpie yacht by Mr. A. Williams.

Meetings held each Friday at 8 p.m. at Old Garrett Hotel, Princess Street, Manchester. Hon. Sec. and Treasurer, H. STUBBS, 23, Ashdene Road, Heaton Mersey, Manchester.

Leicester Society of Model Engineers

A track meeting will be held in the grounds of our chairman's private residence, "Holmwood," Groby Road, Leicester, on Saturday, May 11th, meeting at 2.30 p.m. A portion of Mr. Chapman's track, about 120 ft., has been constructed to carry $2\frac{1}{2}$ in., $3\frac{1}{2}$ in., 5 in. and 6 in. gauge locos., and it is hoped that the work on the continuous portion, about 500 ft., and to carry 5 in. and 6 in. gauge locos., will be completed by the above date. Joint Hon. Sec., E. DALLASTON, 25, Bainbridge Road, Braunstone Estate, Leicester.

The City of Bradford Model Engineers' Society

We had a "Display Night" recently, on which members brought models for all to see. We have continued the usual bi-monthly meetings, and attendances have never been below 25. Our membership, too, is rising again.

On May 21st at Mech. Institute, 7.30 p.m., Mr. S. F. Benson, M.Sc., A.M.I.Mech.E., of the Technical College, will continue his talk on internal combustion engines which he was unable to finish on March 19th. He had to break off at a very interesting point for lack of time, so we are looking forward to the continuation. Hon. Sec., G. C. ROGERS, 8, Wheatlands Grove, Daisy Hill, Bradford.

Hull Society of Model Engineers

Will members and anyone else concerned kindly note that the new address of the Hon. Sec., E. BELLAMY, is now 49, Wold Road, Hull.

NOTICES.

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matter intended for publication should be clearly written on one side of the paper only, and should invariably bear the sender's name and address. Unless remuneration is specially asked for, it will be assumed that the contribution is offered in the general interest. All MSS. should be accompanied by a stamped envelope addressed for return in the event of rejection.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All subscriptions and correspondence relating to sales of the paper and books to be addressed to Percival Marshall and Co. Ltd., 60, Kingsway, London, W.C.2. Annual Subscriptions, £1 10s., post free, to all parts of the world. Half-yearly bound volumes 17s. 6d., post free.

All correspondence relating to advertisements to be addressed to THE ADVERTISEMENT MANAGER, "The Model Engineer," 60, Kingsway, W.C.2.